The effect of N-fertilization rate or inclusion of red clover to timothy leys on fatty acid composition in dairy cow milk

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Introduction

There is growing awareness among consumers of the link between diet and health. Further, the public often associates dairy products with coronary heart disease, since most of the fatty acids (FA) in milk are saturated. Therefore, it would be desirable to improve the FA profile of milk, which might be achieved by using appropriate feeding regimes. N-fertilization has been shown to influence both total fatty acid (TFA) content and the FA composition in a wide variety of species (Arvidsson 2009). The aim of this experiment was to evaluate the effects of grass silages subjected to different N fertilisation regimes fed to dairy cows on the FA composition of their milk, and to compare the grass silages in this respect to red clover-dominated silage, under typical Swedish production conditions.

Methods

The experiment was conducted at Röbäcksdalen Research Centre, Swedish University of Agricultural Sciences, Umeå, Sweden (63°45′N; 20°17′E). Grass silages made from first year *Phleum pratense* L. leys subjected to three N fertilization regimes (30, 90 and 120 kg N/ha, designated G-30, G-90 and G-120, respectively) and a mixed red clover-grass silage (*Trifolium pratense* L. and *P. pratense* L.; 60/40 on DM basis, designated RC-G) were produced. The silages were field wilted to a DM of about 300 g/kg. The experiment was conducted as a change-over design (Patterson and Lucas, 1962), including 24 primi- and multiparous dairy cows of the Swedish Red breed, each of which was allocated to three of the four diets. The design included three experimental periods, each four weeks long. The cows were offered 11 kg dry matter (DM) of silage and 7 kg in total of two commonly used standard commercial concentrates. Lipids of feed samples were extracted using the method described by Raes *et al*. (2001) and for determining FA concentrations of milk samples, the Röse-Gottlieb procedure (ISO-3889; ISO, 2006) was used. Fatty acid methyl esters were then quantified by gas chromatography. Mixed linear models were used for the statistical analyses and the treatment effect was divided into the following orthogonal comparisons: 1) red clover containing silage *vs.* N-fertilized grass silages, 2) linear and 3) quadratic effects of increasing N-fertilization. Differences were considered significant if $P < 0.05$.

Results

The silages had similar DM and energy concentrations(average 310 g DM/kg and 10.8 MJ/kg DM). The CP concentration increased with increases in N fertilization level (125, 134, 142 and 149 g/kg DM for G-30, G-90, G-120 and RC-G, respectively). There was a linear increase in DM intake of the different silages with increased N fertilization (Table 1). There were also differences in concent-

Table 1. Daily feed intake (kg/day) and fatty acid (FA) intake (g/day) from the experimental diets.

	G-30	G-90	G-120	RC-G	s.e.[1]	Contrasts[2]		
						S	L	Q
Silage intake	9.3	9.6	10.8	10.5	0.35	NS	**	NS
Total diet								
16:0	120	123	123	123	1.63	NS	*	NS
18:0	16.1	16.3	16.3	16.7	0.16	***	NS	NS
c9-18:1	105	106	107	105	1.33	*	NS	NS
18:2n-6	97.0	100	101	103	1.48	**	**	NS
18:3n-3	76.1	94.3	99.0	90.0	2.77	NS	***	*
Other	23.9	24.2	24.7	25.0	0.33	**	*	NS
Total FA	442	467	475	467	7.16	NS	***	NS

[1] Standard error of mean; [2] S, clover-grass silage vs. grass silages; L, linear effect of N-fertilization; Q, quadratic effect of N-fertilization; NS, non significant; *, $P<0.05$; **, $P<0.01$; ***, $P<0.001$

Table 2. Effect of silage on milk fatty acid (FA) concentrations (g/100 g FA).

	G-30	G-90	G-120	RC-G	s.e.[1]	Contrasts[2]		
						S	L	Q
c9-18:1	19.30	19.67	19.51	19.52	0.426	NS	NS	NS
c11-18:1	0.63	0.62	0.62	0.63	0.016	NS	NS	NS
18:2n-6	1.10	1.03	1.01	1.07	0.030	NS	*	NS
18:3n-3	0.41	0.40	0.40	0.46	0.021	***	NS	NS
c9,t11-18:2	0.63	0.62	0.63	0.66	0.022	***	NS	NS

[1] Standard error of mean; [2] S, clover-grass silage vs. grass silages; L, linear effect of N-fertilization; Q, quadratic effect of N-fertilization; NS, non significant; *, $P<0.05$; **, $P<0.01$; ***, $P<0.001$

rations of both individual and TFAs amongst silages. The G-90 silage had the highest concentration of TFAs, G-30 the lowest and G-120 intermediate concentrations. RC-G had a higher concentration of 18:0 and 18:2n-6 than the grass silages. It should be noted that dietary 18:3n-3 mainly was supplied by the silages whereas a larger proportion of *cis*-9 18:1 and 18:2n-6 originate from the concentrates.

The daily milk production did not significantly differ between treatments (average 20.9 kg/day), but G-30 silage resulted in higher concentrations of 18:2n-6 in the milk than the other two grass silages (Table 2). The highest concentrations of 18:3n-3 and c9,t11-18:2 were found in milk from cows offered the RC-G silage. The G-30 diet resulted in higher concentration of 18:2n-6 and the same concentration of 18:3n-3 in the milk as the other grass silages, despite lower intake levels of these FAs. The apparent recoveries of 18:3n-3 from feed to milk were 5.74, 4.27, 4.10 and 5.31 % for G-30, G-90, G-120 and RC-G, respectively. A higher recovery when red clover is included in the diet confirms previous reports (Dewhurst *et al*. 2003; Al-Mabruk *et al*. 2004). The higher apparent recovery of 18:3n-3 on the G-30 treatment may be related to the lower silage DM intake which led to a higher relative proportion of ingested FAs originating from concentrates compared with the G-90 and G-120 diets.

Conclusion

Increasing levels of N fertilization to grass led to increasing concentrations of CP in silage. Increasing N fertilization also led to higher concentrations of 18:2n-6 and 18:3n-3 in the G-90 and G-120 silages compared to G-30 silage. However, with the rates and types of concentrates used in this study, the achieved differences in FA composition among the silages were not large enough to have any major effect the milk FA composition. This shows that increasing N fertilization to reach a higher concentration of polyunsaturated FA, or inclusion of red clover in the diet, do not necessarily lead to a higher concentration of polyunsaturated FA in the milk when concentrates are used at standard rates in Swedish systems.

References

Arvidsson K (2009) Factors Affecting Fatty Acid Composition in Forage and Milk. Doctoral Thesis, Swedish University of Agricultural Sciences, Umeå

Al-Mabruk RM, Beck NFG and Dewhurst RJ (2004) Effects of silage species and supplemental vitamin E on the oxidative stability of milk. *Journal of Dairy Science* **87**, 406-412.

Dewhurst RJ, Fisher WJ, Tweed JKS and Wilkins RJ (2003) Comparison of grass and legume silages for milk production. I. Production responses with different levels of concentrate. *Journal of Dairy Science* **86**, 2598-2611.

ISO 2006. ISO 3889—Milk and milk products—specification of Mojonnier-type fat extraction flasks. In International Organisation for Standardisation, Geneva, Switzerland.

Patterson HD and Lucas HL (1962) Change-over designs. In: Technical Bulletin No. 147 North Carolina Agricultural Experiment Station and United States Department of Agriculture, NC, USA.

Raes K, De Smet S and Demeyer D 2001. Effect of double-muscling in Belgian Blue young bulls on the intramuscular fatty acid composition with emphasis on conjugated linoleic acid and polyunsaturated fatty acids. *Animal Science* **73**, 253-260.

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